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(71) Applicant: GEC-MARCONI LIMITED
The Grove, Warren Lane
Stanmore, Middlesex HA7 4LY (GB)

(72) Inventor: Ingleton, Martin
la Chapel Street, Minster
Sheerness, Kent, ME12 3QS (GB)

(74) Representative: Pope, Michael Bertram
Wingate
The General Electric Company, p.l.c. GEC
Patent Department Waterhouse Lane
Chelmsford, Essex CM1 2QX (GB)

(54) Display system.

(57) A helmet mounted display system comprising an eyepiece (3) through which a wearer of the helmet directly views a forward scene (13). The eyepiece also serves to combine an intensified image of the forward scene with the wearer's direct view of the scene. The intensified image is produced by an optical arrangement including an image intensifier (6) from which light is passed to the eyepiece via a prism means (2). The prism means serves to compensate for orientation of the intensified image in other parts of the optical arrangement so that the intensified image is in the same orientation as the wearer's direct view of the forward scene. In addition the prism means allows the various components in the system light path to conform to the profile of the helmet thereby making the helmet more comfortable for a wearer.

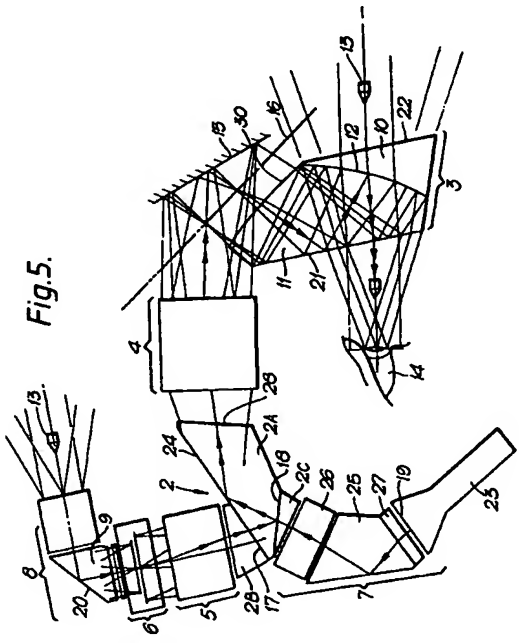

Fig.5.

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This invention relates to a display system, more particularly, to a helmet mounted display system of the kind which provides a wearer of the helmet with a direct view of a scene forward of the helmet wearer on which is superimposed an intensified image of said scene, e.g. for night vision.

In such a system it is desirable for the components of the system to be relatively positioned so as to distribute the weight of the system around the helmet in a balanced manner, and thereby make the helmet comfortable in use for the wearer. This is difficult to achieve whilst at the same time obtaining an intensified image of the forward scene which is in the same orientation as the wearer's direct view of the forward scene. Known arrangements typically use a so-called Peckham prism which has five internal faces at which reflection of light takes place, and consequently is bulky and has an inconveniently long equivalent length.

It is an object of the present invention to provide a display system when the attainment of these two requirements is facilitated.

According to the present invention there is provided a helmet mounted display system comprising: an eyepiece through which a wearer of the helmet can directly view a forward scene and which also serves to combine an intensified image of the forward scene with the wearer's direct view of said scene, characterised in that the intensified image is produced by an optical arrangement providing a light path substantially conforming to the profile of the helmet and incorporating prism means which serves to compensate for orientation of the intensified image in other parts of the optical arrangement.

In order that the invention may be fully understood, one example of a display system in accordance therewith will now be described with reference to the accompanying drawings in which:-

Figure 1 is a side view of the system;

Figure 2 is a top view of the system;

Figure 3 is a view of the system in the direction of the arrow A of Figure 1;

Figure 4 is a view of the system in the direction of the arrow B in Figure 3; and

Figure 5 is an optical schematic view of the system showing the arrangements of the lenses and prisms and indicating the light path therein.

Referring now to the drawings, conformity of the display system to the general helmet profile 29 (Figure 2) is achieved by a number of reflections internally of the system to steer the optical path in the desired directions. The number and angular relationship of the reflections are critical to ensure than an intensified image of a night scene forward of the user, as viewed by an objective lens 1, is synchronised with a user's direct view of the scene through an eyepiece 3. The opto-mechanical arrangement to achieve this orientation synchronisation is arranged to provide an even number of reflections, six, which have sufficient separation and size to accommodate a lens system necessary to achieve optical performance. The enabling component is a 2-reflection prism means 2 shown schematically in Figure 5, hereinafter referred to as the de-rotation prism.

Compound reflections between the input and exit surfaces 17 and 18 of a main portion 2A of the de-rotation prism 2 provide the necessary compensating image rotation to ensure that the intensified forward scene image regarded by the user is in the same orientation as the directly viewed scene through the eyepiece 3. The reflection surface 18 of the de-rotation prism 2 is optically coated so as to be partially reflective, thus allowing an introduction of additional display information into the intensified forward scene image display channel.

Selection of the position and size of the de-rotation prism 2 allows sufficient separation and a clear optical diameter for the eyepiece 3, a main relay lens group 4, an intensified image relay group 5, an image intensifier 6 and an additional display information channel 7, keeping within the physical constraints of the 3-dimensional system. An objective lens group 8 of which the objective lens 1 constitutes the first element couples to the input of the image intensifier 6 and completes the 3-dimensional optical system.

On-axis spherical lenses (not shown) constitute the active optical elements within the objective lens assembly 8. These lenses are grouped into two areas, one before and one after a fold prism 9. This prism 9 causes the optical path to turn through approximately 90°, the folding reflection being made by surface 20.

A bright display of the forward night scene, provided by the image intensifier 6, is viewed by the user via the combination of the eyepiece 3, the relay lens groups 4 and 5 and the de-rotation prism 2, light exiting the lens group 4 being directed into the eyepiece 3 by a folding reflection at a mirror surface 15.

The eyepiece 3 comprises two plastic prismatic elements 10 and 11 which mate at a common off-axis spherical surface 12. The off-axis surface 12 has a partially reflective coating to allow the user to view the forward outside world scene 13 through parallel planar aft and fore external faces 21, 22 and internal surface 12 of the eyepiece 3, and the images generated by either or both the image intensifier 6 and the additional display channel 7 by reflection at surface 12. The surface 12 is concavely curved towards the aft external face 21 so that the images viewed by the user are collimated.

The functions of the eyepiece 3 and other elements of the system will now be described, as is conventional, working from a user's eye 14 back to the display sources.

From the user's eye 14 light is reflected back from the off-axis spherical surface 12 to the aft surface 21 of the rear prism 11 of the eyepiece 3. This surface

21 is arranged at a sufficiently shallow angle to ensure the light is again reflected by total internal reflection (TIR) through an input face 30 of the prism 11 of the eyepiece 3 to the planar mirror surface 15. An intermediate image plane 16 of distorted nature is formed before the mirror 15; the distortion being a result of the off-axis spherical reflection at surface 12.

Light couple between the intermediate image plane 16 and the two display sources 6 and 7 is achieved by the relay lens group 4 and the de-rotation prism 2. The relay group 4 serves partially to correct the eyepiece abberations. Light then passes to the de-rotation prism 2 via exit face 28 and meets a surface 24 of portion 2A of the prism 2 at a shallow angle to cause a reflection by TIR towards the partially reflective surface 18, the surface 24 being coplanar with surface 17 in the embodiment described. At the surface 18 the two displays are combined according to the ratio of reflection to transmission. Depending on which display is considered, the final eyepiece intermediate image correction is achieved by lens group 5 or in additional display channel 7, the relayed image planes being formed at the image intensifier 6 or at additional display source 19, illustrated in Figure 5 as the screen of a cathode ray tube 23. Surfaces 17 and 18 are coupled to lens groups 5 and 7 via respective wedge potions 2B and 2C of de-rotation prism 2, the input faces of wedge portions 2B and 2C being parallel to the output faces of lens group 5 and channel 7 respectively. In addition to cathode ray tube 23, the channel 7 includes a pathfolding prism 25 and lens groups 26 and 27 on either side of prism 25.

It will be appreciated that the user at 14 is able to see not only the scene ahead 13 but also to have it intensified by the image intensifier 6, which is particularly useful for night time vision. In addition to this the additional display source 19 enables further information simultaneously to be fed through the de-rotation prism 2 so that it can be viewed together with the night scene so as to further inform the user.

The complex faceted prism means 2 between image intensifier 6 and eyepiece 3 provides compensating image rotation with high transmission efficiency, short optical path length and a large clear diameter together with the ability to combine displays. The system is able to be mounted on a helmet so as to conform to the profile of the helmet as shown in Figure 2.

Claims

1. A helmet mounted display system comprising: an eyepiece (3) through which a wearer of the helmet can directly view a forward scene (13) and which also serves to combine an intensified image of the forward scene (13) with the wearer's direct view of said scene, (13) characterised in that the intensified image is produced by an optical arrangement (4, 5, 6, 8) providing a light path substantially conforming to the profile (29) of the helmet and incorporating prism means (2) which serves to compensate for orientation of the intensified image in other parts of the optical arrangement (4, 5,6, 8).

2. A system according to Claim 1 wherein said prism means (2) comprises: a first face (17) through which light representing the intensified image passes to be incident on a second face (18) at which said light is reflected towards a third face (24) at which said light is internally reflected to be directed towards a fourth face (28) via which said light exits the prism means (2).

3. A system according to Claim 2 wherein said light representing said intensified image passes to said first face (17) via an adjacent wedge portion (2B) of said prism means (2).

4. A system according to Claim 2 or Claim 3 wherein said light representing said intensified image is produced in an image intensifier (6) coupled to said first face (17) of the prism means (2) via a first lens group (5) and to an objective lens (1) via a second lens group (8).

5. A system according to Claim 4 wherein said second lens group (8) incorporates a prism (9) to provide a desired turn in the optical path between the objective lens (1) and image intensifier (6).

6. A system according to Claim 5 wherein said second lens group (8) includes lenses before and after said prism (9).

7. A system according to any one of Claims 2 to 6 wherein said light representing said intensified image passes to said eyepiece (3) from said fourth face (28) via a further lens group (4) and a reflecting mirror surface (15).

8. A system according to any one of the preceding claims wherein said eyepiece (3) incorporates an internal curved surface (12) possessing both light transmitting and reflecting properties which serves as a collimating reflector for said light representing the intensified image and through which a user (14) views the forward scene (13).

9. A system according to Claim 8 wherein said internal curved surface (12) lies between flat parallel fore and aft faces (22, 21) of the eyepiece (3) through which the user (14) views the forward scene (13) , said curved surface (12) being concavely curved towards said aft face (21), said

light representing said intensified image entering said eyepiece (3) via a face (30) between said fore and aft faces (22, 21), for internal reflection at said aft face (21) forwardly onto said curved surface (12) from which it is reflected rearwardly through said aft face (21) to the user (14).

10. A system according to any one of Claims 2 to 9 wherein said second face (18) is partially reflective and the system includes means (7) for introducing light representing a further display into the prism means (2) via said second face (18) for combination with said light representing the intensified image.

11. A system according to Claim 10 wherein said light representing said further display passes to said second face (18) via an adjacent wedge portion (2C) of said prism means (2).

12. A system according to Claim 10 or Claim 11 wherein said light representing said further display passes to said prism means (2) via a further prism means (25) to provide a desired turn in the optical path between a source (19) of said light representing said further display and said second face (18).

13. A system according to Claim 12 including further lenses (26, 27) on either side of said further prism means (25).

Fig.1.

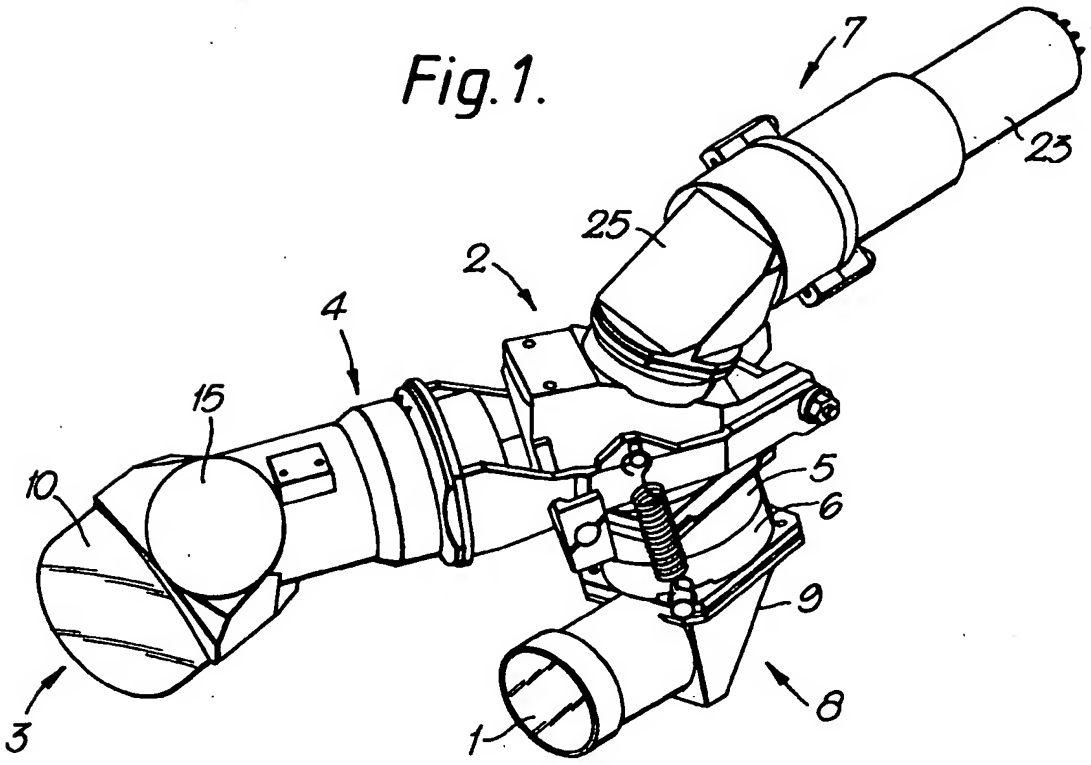


Fig.3.

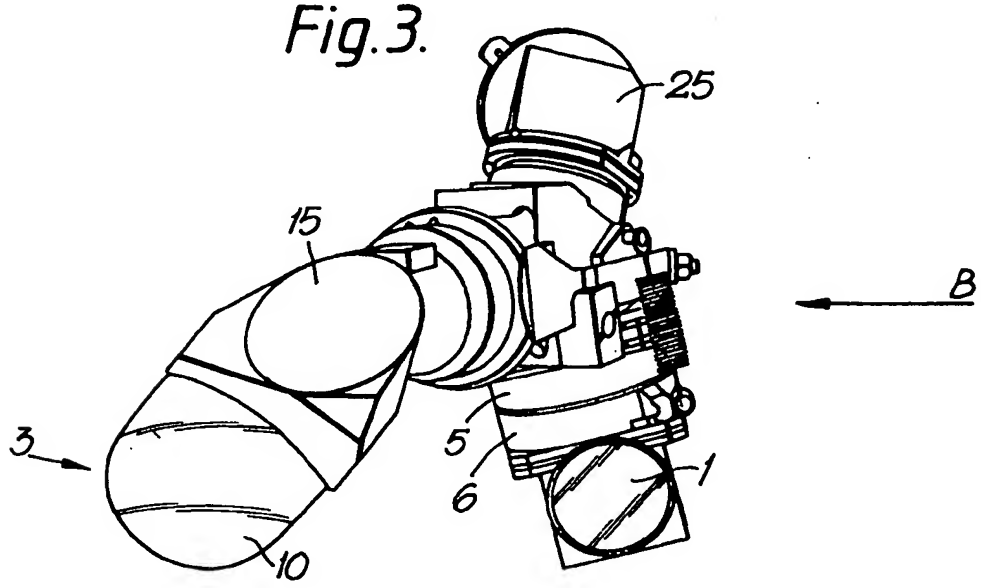


Fig. 2.

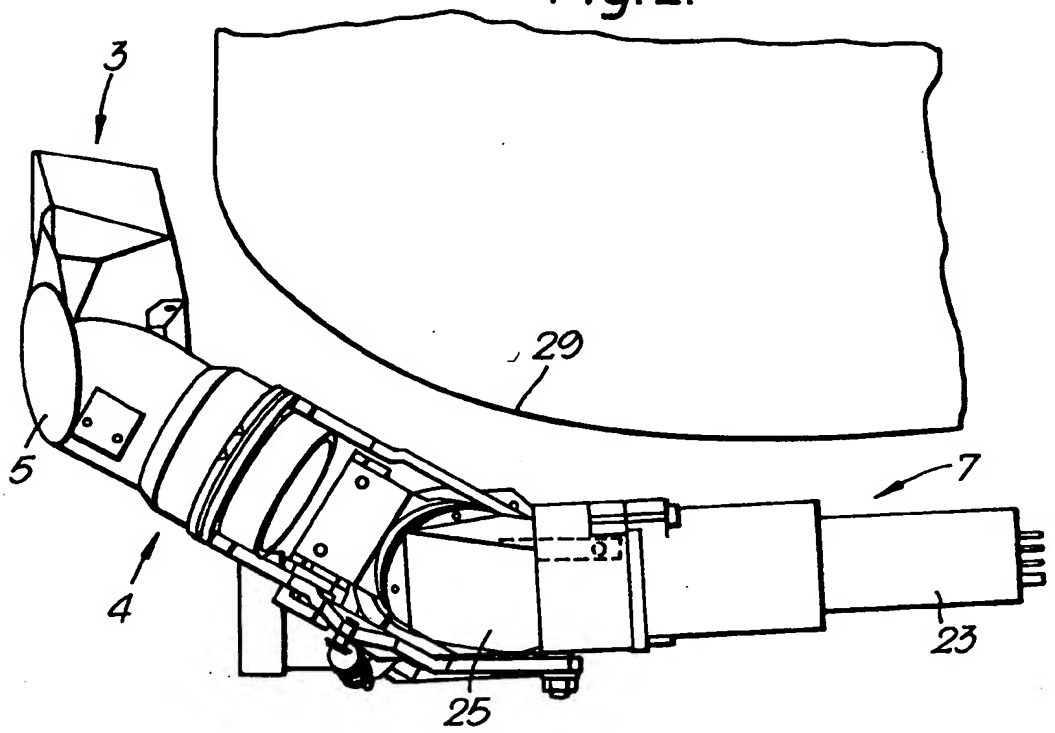
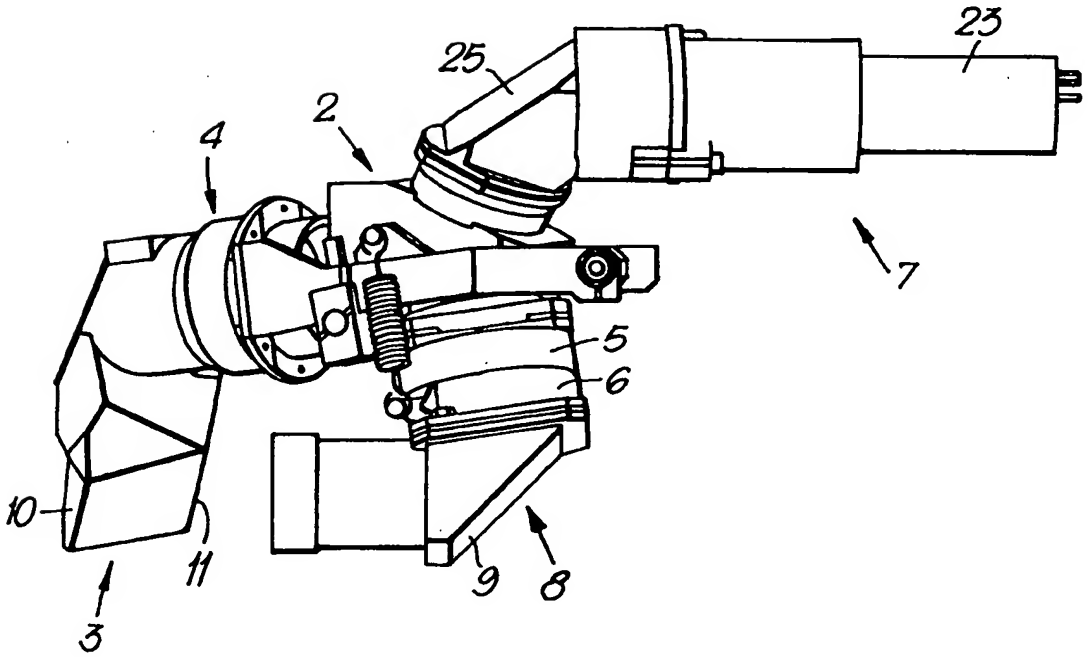


Fig. 4.



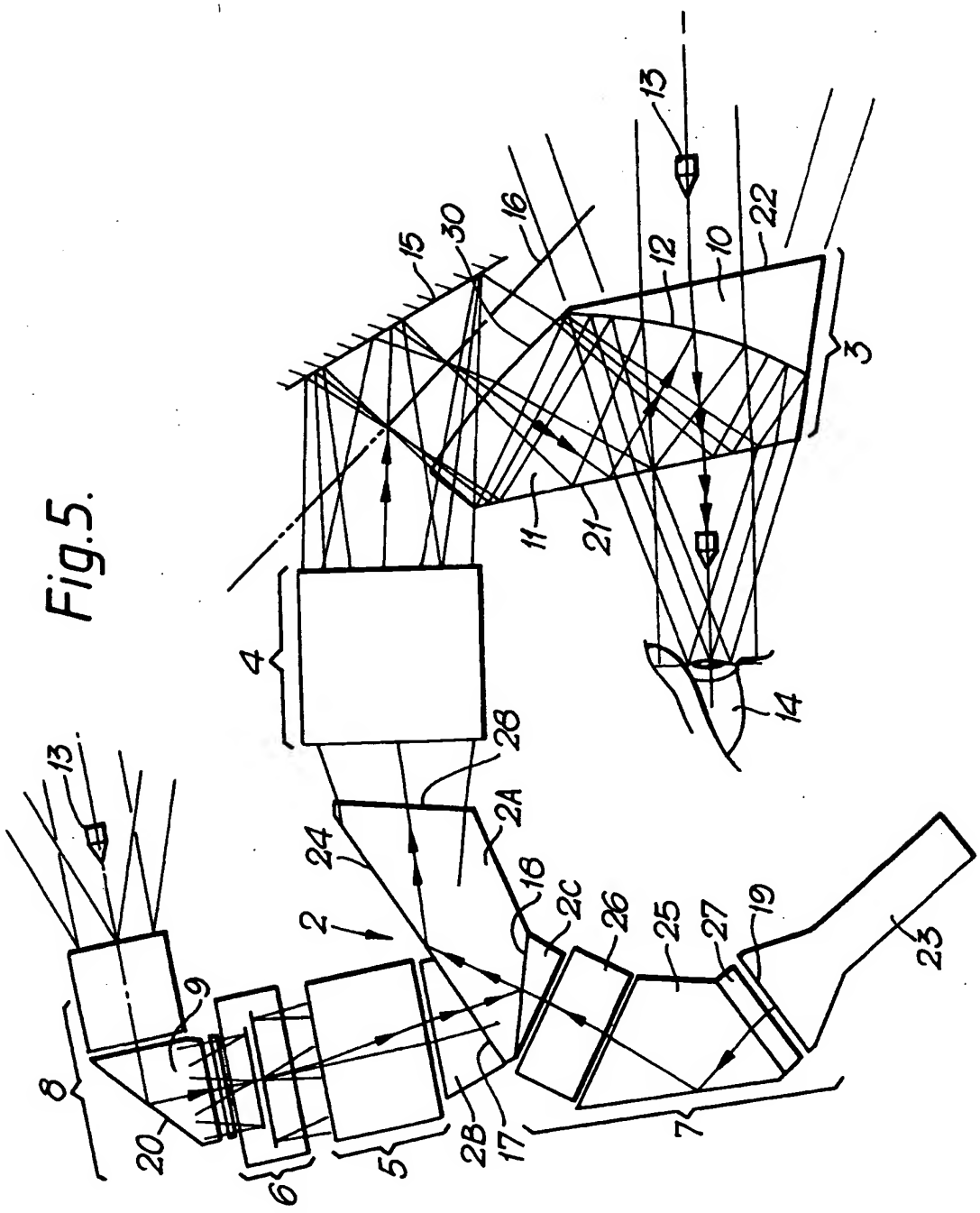

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Fig.5.